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GROWTH, DEVELOPMENT, AND FOOD HABITS OF NESTLING MIMIDS IN SOUTH TEXAS

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The growth rates of nestling passerines recently have received considerable study (Ricklefs 1968, 1979; Best 1977; Woolfenden 1978); however, few studies have examined mimids (Mimidae) (but see Rand 1941; Killpack 1970; Ricklefs 1965, 1966). Food habits of nestling mimids are also poorly known (see Bent 1948). In this paper I report on growth, development, and food habits of nestling Curve-billed Thrashers (*Toxostoma curvirostre*), Long-billed Thrashers (*T. longirostre*), and Northern Mockingbirds (*Mimus polyglottos*) in south Texas. Each of these mimids is an abundant resident of the brushlands typical of this region.

METHODS

I studied the breeding ecology of Curve-billed and Long-billed thrashers and mockingbirds during the summers of 1977 and 1978 near Dinero, Live Oak Co., Texas. Two rectangular study areas were selected and the vegetation of each sampled with 25 randomly located line-transects (30.5 m) (Canfield 1941). Botanical nomenclature follows Jones (1975).

Plot A (30.3 ha) supported a dense, often impenetrable chaparral (185.5% cover, overlapping vegetative layers) comprised mostly of the following shrubs: colima (*Zanthoxylum fagara*), blackbrush acacia (*Acacia rigidula*), agarito (*Berberis trifoliata*), brasil (*Condalia hookeri*), granjeno (*Celtis pallida*), and mesquite (*Prosopis glandulosa*). The remaining cover was formed by trees (19.6%), forbs (25.3%), and grasses (16.9%). Two sides of plot A bounded additional chaparral, and two sides bordered a cleared pasture.

Plot B (69.0 ha) was cleared several years prior to my study. Shrubs contributed only 7.6% and trees 2.4% of the total 104.9% cover. Forbs, especially gerardia (*Gerardia heterophyla*), broom snakeweed (*Xanthocephalum sarothrae*), and golden aster (*Heterotheca latifolia*), privided 73.6% of the vegetative cover. The remaining 21.3% was formed by grass. All of the Long-billed Thrasher nests were located in plot A. Most Curve-billed Thrasher and mockingbird nests were found in plot B or along the periphery of plot A (Fischer 1980).

Nests were visited between 12:00 and 16:00 at 2-day intervals. On each visit I recorded the weight and wing chord as well as the tarsometatarsus and bill lengths (culmen-nostril) of each nestling. The stage of feather development was also noted. Day 0 designates the day of hatching. Curve-billed Thrashers were measured through day 9, and Long-billed Thrashers and mockingbirds through day 8. Young disturbed beyond these ages would not remain in the nest when replaced, and prematurely fledged. Curve-billed Thrashers normally fledged on day 13, Long-billed Thrashers on day 12, and mockingbirds on day 10 (Fischer 1980).

Ricklefs (1967) presented a graphical method of fitting equations to growth curves. Following his procedures, I found that the growth of the three mimids was best expressed by the logistic equation:

$$W_{(t)} = A/(1 + e^{-K(t - t_i)})$$

where $W_{(t)}$ is the weight at age t, A is the asymptote, K is the growth rate constant, and $t_{(i)}$ is the age at the inflection point (A/2) of the growth curve. The slopes of the growth curves of the wing (carpometacarpus to wing tip), bill, tarsometatarsus, and weight of each species were compared for significant differences using analysis of covariance (Snedcor and Cochran 1976). Growth rate data from 1977 and 1978 were tested, found not to differ significantly, and combined in the following discussion. The level of significance accepted in this study was $P < 0.05$.

Food samples were collected from nestlings between days 3 and 8 or 9 in 1978 using pipe-cleaner ligatures (Orians 1966). Samples were collected throughout the day and stored in 75% isopropyl alcohol. Later, these were identified to family, and measured volumetrically in a 5-cc calibrated test-tube. The diets of the mimids were compared using Schoener's (1968) index of overlap: $D = 1 - \frac{1}{2} \Sigma \left|(x_{i,1} - y_{i,1})\right|$ where $x_{i,1}$ and $y_{i,1}$ are the frequencies of the i^{th} category for species X and Y.

Food availability was assessed by collecting 50 samples monthly in 1978. Each sample consisted of sweeping 1 m^2 of herbaceous growth 25 times with a net, and collecting all potential prey from 1 m^2 of ground surface; items were stored and analyzed as described above for nestling diets. Chi-square analysis (Snedecor and Cochran 1976) was used to compare nestling Curve-billed Thrasher diets with food availability to determine dietary preferences, and to compare the proportions of the major taxa for monthly differences.

RESULTS AND DISCUSSION

General Development

At hatching, each of the mimids was typically altricial and sparsely covered with grayish-black down (Curve-billed and Long-billed thrashers) or a lighter, smokey-gray down (mockingbird). The internal organs were clearly visible through the translucent skin. The skin pigmentation of both species of thrashers was pinkish-red dorsally and whitish-red ventrally, whereas the skin pigmentation of nestling mockingbirds was orange with no tongue spotting, and the tomia and ricti were yellow.

As nestlings aged, dorsal skin pigmentation darkened to reddish-brown on the thrashers, and to a deep orangish-brown on mockingbirds. Nestlings' eyes began to open on day 3 (mockingbird) or day 4 (thrashers) and were fully open 1 day later. By day 2, papillae had emerged from all pterylae on each species, and between days 3 and 4, sheaths began to emerge from these. The first sheaths erupted on day 5 (mockingbirds) or day 6 (thrashers) on the lower spinal and ventral tracts. By day 8, most sheaths on all tracts except the capital had shattered, and at fledging, virtually all sheaths had erupted.

Growth

Wing chord.—The longest primary included in wing chord measurements (primary 7) erupted from the sheath on day 7 for mockingbirds or

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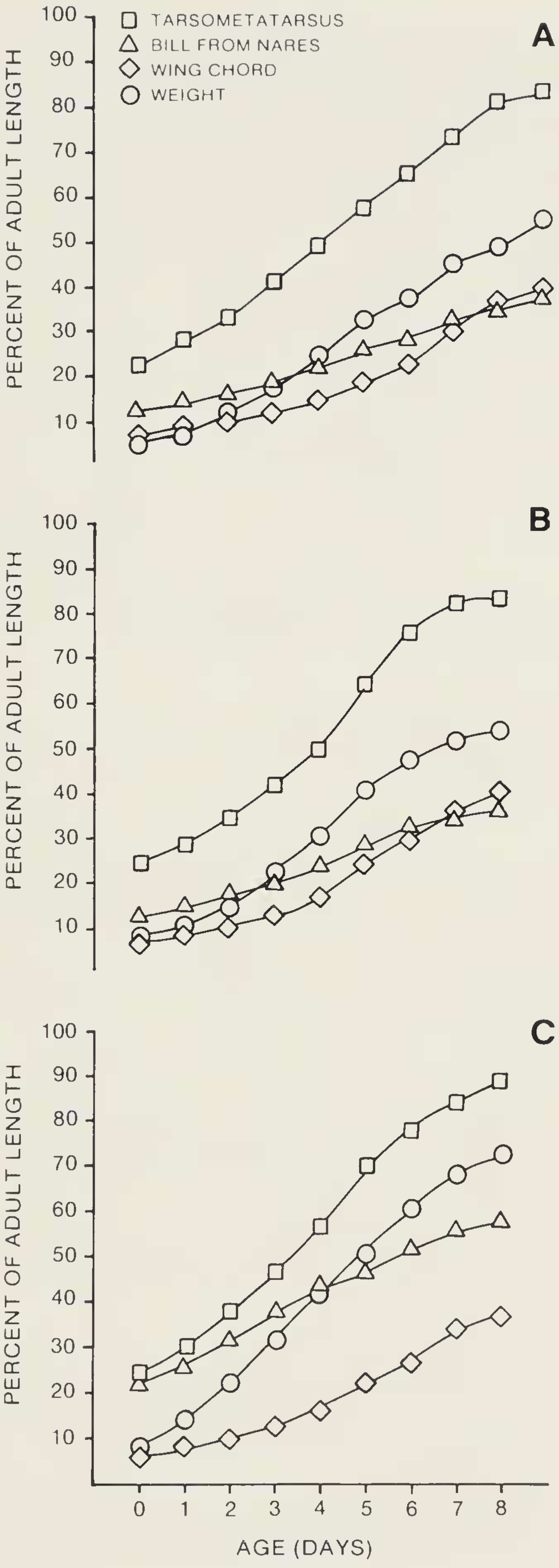
FIG. 1. Growth parameters of nestling (A) Curve-billed Thrasher, (B) Long-billed Thrasher, and (C) Northern Mockingbird.



TARSOMETATARSUS
BILL FROM NARES
WING CHORD
WEIGHT
A
B
C
PERCENT OF ADULT LENGTH
AGE (DAYS)

day 8 for thrashers. Adult mockingbirds had considerably longer wing chords than either of the two thrashers; however, the growth rates of nestling wing chords of each species were similar (Fig. 1a–c), and not significantly different. By day 8, the wing chord had attained 36.0% ($\bar{x}$ = 36.7 ± 4.5 SE mm, N = 22), 41.4% ($\bar{x}$ = 39.8 ± 3.9 mm, N = 3), and 34.7% ($\bar{x}$ = 38.8 ± 3.5 mm, N = 10) of adult wing lengths of Curve-billed Thrashers ($\bar{x}$ = 102.1 ± 4.1 mm, N = 31), Long-billed Thrashers ($\bar{x}$ = 96.1 ± 2.9 mm, N = 95), and mockingbirds ($\bar{x}$ = 111.5 ± 6.8 mm, N = 15), respectively. None of the young could fly when they left the nest.

Bill and tarsometatarsus.—By day 8 the bill length of nestling mockingbirds had grown to 59.6% ($\bar{x}$ = 6.5 ± 0.3 mm, N = 10) of adult length ($\bar{x}$ = 10.9 ± 1.3 mm, N = 15), compared to 30.0% ($\bar{x}$ = 8.2 ± 0.8 mm, N = 22) for nestling Curve-billed Thrashers (adult $\bar{x}$ = 27.3 ± 1.1 mm, N = 31) and 38.2% ($\bar{x}$ = 8.3 ± 0.4 mm, N = 3) for nestling Long-billed Thrashers (adult $\bar{x}$ = 21.7 ± 0.9 mm, N = 95). This difference was attributable to the much longer bill lengths of adult thrashers when compared with adult mockingbirds, and to a significantly (F = 27.2; df = 2, 688; $P < 0.01$) greater growth rate of the bill of nestling mockingbirds when compared with the thrashers.

The tarsometatarsus of each mimid developed more rapidly than any other appendage measured (Fig. 1a–c). By day 8, they had attained 80.8% ($\bar{x}$ = 27.8 ± 2.6 mm, N = 22), 82.4% ($\bar{x}$ = 29.4 ± 4.4 mm, N = 3), and 89.3% ($\bar{x}$ = 29.9 ± 1.3 mm, N = 10) of adult lengths of Curve-billed Thrashers ($\bar{x}$ = 34.4 ± 1.1 mm, N = 31), Long-billed Thrashers ($\bar{x}$ = 35.7 ± 1.2 mm, N = 95), and mockingbirds ($\bar{x}$ = 33.5 ± 1.3 mm, N = 15), respectively. The growth rates of the tarsometatarsus of the two thrashers did not differ significantly, but both developed slower (F = 64.9; df = 2, 688; $P < 0.01$) than the tarsometatarsus of mockingbirds.

Weight.—At hatching, while still wet, Curve-billed Thrashers weighed 5.8% ($\bar{x}$ = 4.9 ± 0.4 g, N = 24) of adult weights (Table 1), Long-billed Thrashers 6.2% ($\bar{x}$ = 4.2 g, N = 2), and mockingbirds 7.5% ($\bar{x}$ = 3.6 ± 0.3, N = 17). Weight gain in all three species was rapid and by day 8, the young weighed 49.1%, 55.2%, and 73.0% of adult Curve-billed Thrasher, Long-billed Thrasher, and mockingbird weights, respectively (Fig. 1a–c, Table 1). The growth rate of the thrashers did not differ significantly; however, mockingbirds increased in weight at a greater rate (F = 91.3; df = 2, 688; $P < 0.01$) than either thrasher.

Using Ricklefs' (1967) procedures, I calculated the following values for the growth rate equation of each species: A = 55.6 g, $t_{(i)}$ = 5.9 days, and K = 0.444 for the Curve-billed Thrasher, A = 49.9 g, $t_{(i)}$ = 5.9 days, and K = 0.443 for the Long-billed Thrasher, and A = 39.1 g, $t_{(i)}$ = 4.8 days, and K = 0.452 for the mockingbird. The predicted asymptotes (A) of Curve-

TABLE 1

AVERAGE WEIGHTS (G) OF NESTLING CURVE-BILLED THRASHERS (CBT), LONG-BILLED THRASHERS (LBT), AND NORTHERN MOCKINGBIRDS (MOCK)

Age (days)	CBT		LBT		MOCK	
	N	$\bar{x} \pm SD$	N	$\bar{x} \pm SD$	N	$\bar{x} \pm SD$
0	43	5.59 ± 0.69	5	5.60 ± 1.53	54	4.59 ± 0.79
1	33	7.96 ± 1.06	5	7.68 ± 1.34	52	7.21 ± 0.96
2	44	11.70 ± 1.71	10	10.72 ± 2.01	45	11.00 ± 1.77
3	38	16.92 ± 3.42	8	15.42 ± 2.11	64	15.53 ± 2.66
4	40	21.81± 3.82	2	20.90 ± 1.27	40	20.57 ± 2.91
5	35	27.99 ± 5.15	3	28.16 ± 5.84	49	24.74 ± 2.75
6	22	32.05 ± 5.45	3	32.53 ± 1.46	46	29.47 ± 3.04
7	23	38.93 ± 3.36	5	35.44 ± 2.37	12	33.23 ± 3.37
8	22	41.84 ± 6.38	3	37.33 ± 1.20	10	34.99 ± 4.04
9	13	47.62 ± 5.12	—	— —	—	— —
Adult	31	85.23 ± 6.07	95	67.65 ± 5.46	15	47.81 ± 3.83

billed Thrashers and mockingbirds agree closely with the limited number of nestling weights that I have from the final day prior to fledging: Curve-billed Thrasher, $\bar{x}$ = 53.4 ± 2.6 g, N = 6; mockingbird, $\bar{x}$ = 40.4 ± 2.7 g, N = 3). I have no measurements of Long-billed Thrashers from days 11 or 12. Growth constants for the Curve-billed Thrasher in Arizona were: A = 55.0 g, $t_{(i)}$ = 6.3 days, and K = 0.384 (Ricklefs 1968). I analyzed Killpack's (1970) weight gain data of the Sage Thrasher (*Oreoscoptes montanus*) and again found the logistic equation best described the pattern of growth, with constants of A = 34.1 g, $t_{(i)}$ = 4.3 days, and K = 0.543.

The time required to grow from 10% to 90% (t_{10-90}) of the asymptote (Ricklefs 1967) of the Curve-billed Thrasher was 9.88 days, that of the Long-billed Thrasher, 9.90 days, that of the mockingbird, 9.70 days, and that of the Sage Thrasher (using Killpack's 1970 data), 8.05 days. In Arizona, Ricklefs (1968) reported a greater t_{10-90} value, 11.5 days, for the Curve-billed Thrasher, apparently indicating a longer developmental period. Ricklefs (1965) reported starvation within broods in Arizona, indicating perhaps a scarcity of food during the breeding season. Although brood sizes averaged larger in Texas than in Arizona (3.8 vs 3.0), none of the nestlings died from starvation during this study (Fischer 1980).

The ratio (R) of the asymptote to adult weight describes the nestling development at the time of fledging (Ricklefs 1967) and is correlated with the feeding tactics of the adults: species foraging terrestrially have R values less than 0.9 (Ricklefs 1968). I determined R values of 0.65 for Curve-billed Thrashers, 0.73 for Long-billed Thrashers, 0.82 for mockingbirds,

TABLE 2
DIETS OF NESTLING CURVE-BILLED THRASHERS (CBT), LONG-BILLED THRASHERS (LBT), AND NORTHERN MOCKINGBIRDS (MOCK)

	CBT		LBT		MOCK	
Taxon	% N[a]	% V[b]	% N	% V	% N	% V
Orthoptera	60.4	61.0	50.8	72.8	64.3	67.4
Nymph	34.9	36.6	44.8	60.4	25.6	13.9
Adult	25.5	24.4	7.1	12.4	38.7	53.5
Coleoptera	16.4	15.5	4.4	3.7	0.0	0.0
Lepidoptera	12.4	12.4	12.8	8.8	11.5	14.7
Larvae	6.4	6.6	10.3	5.9	9.3	10.8
Pupae	0.2	0.2	2.5	2.9	0.0	0.0
Adult	5.5	5.6	0.0	0.0	2.2	3.9
Other Insecta	0.0	0.0	10.0	4.2	13.2	9.8
Arachnida	7.0	7.3	8.8	5.7	9.8	7.9
Gastropoda	0.9	1.0	8.8	2.4	1.2	0.2
Berries	2.9	2.8	4.4	2.4	0.0	0.0

[a] Percent of the total items contributed by the respective taxa.
[b] Percent of the total volume contributed by the respective taxa.

and 0.90 for Sage Thrashers (using Killpack's data). Ricklefs (1968) reported a similar R value, 0.69, for Curve-billed Thrashers in Arizona. Thus, curve-bills in both Texas and Arizona apparently fledge at similar weights.

Nestling Food Habits

Composition and overlap.—I collected 433 items (N = 90 nestlings, 32 nests) from nestling Curve-billed Thrashers, 45 items (N = 9 nestlings, 3 nests) from nestling Long-billed Thrashers, and 85 items (N = 56 nestlings, 24 nests) from nestling mockingbirds. Each of the mimids fed their young a diversity of food items (for a complete list see Fischer 1979), almost all of which were terrestrial arthropods. Of these, orthopterans, especially acridids, were the most prevalent items numerically and volumetrically (Table 2). Lepidopteran larvae and Arachnida were important components of the diets of each species, and Coleoptera formed a considerable percentage of nestling Curve-billed Thrasher diet. Berries of agarito and granjeno were fed to young of both thrashers but only after day 7.

The nestling diets of each species overlapped broadly with index values of 0.62 for Curve-billed–Long-billed thrashers, 0.72 for Long-billed Thrasher–mockingbird, and 0.63 for Curve-billed Thrasher–mockingbird. Although the overlap values were considerable, it seems unlikely that

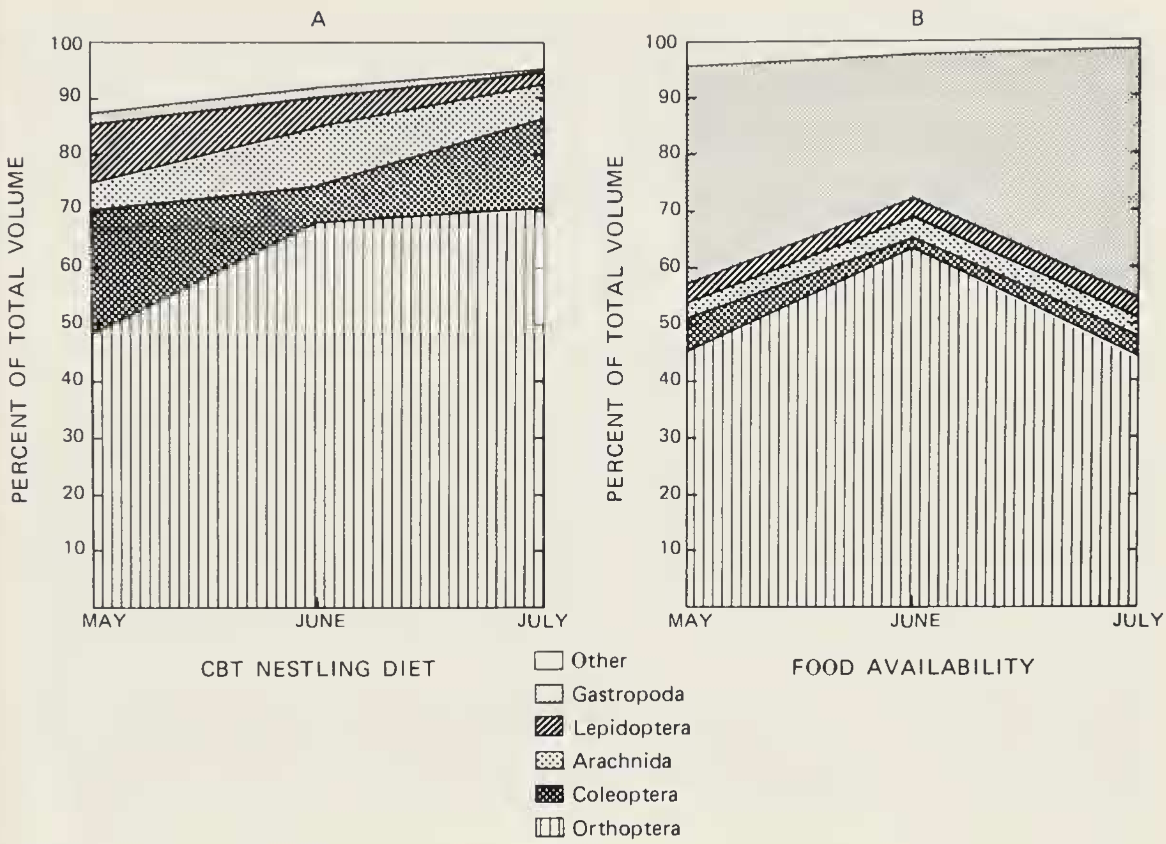


FIG. 2. Variation by month of (A) Curve-billed Thrasher nestling diet and (B) food availability.

competition for food would occur during the summer months since arthropods and gastropods were abundant. In addition, the foraging sites and tactics of the adults differed considerably (Bent 1948, Fischer 1980).

Prior to feeding their young, adults of each species usually removed the heavily chitonized portions of the larger prey. These included the legs of arachnids, and legs, head, and wings of orthopterans and coleopterans. Some very large long-horned grasshoppers (Tettigoniidae) were fragmented and fed to two or more young of a brood. Small prey and all lepidopterans were fed to the young without any apparent processing.

Seasonal distribution of nestling foods.—I compared the monthly diets of nestling Curve-billed Thrashers only, since the sample sizes were small for the other two mimids. The relative importance (proportion) of the major nestling foods changed slightly between May and July (Fig. 2a). Orthopterans significantly ($\chi^2 = 12.6$, df $= 2$, $P < 0.01$) increased in proportion between May and July (Fig. 2a), and predominated during each month. The proportion of coleopterans significantly ($\chi^2 = 8.9$, df $= 2$, $P < 0.01$) declined between May and June. None of the other changes in taxa among months was significantly different.

When the diet of nestling Curve-billed Thrashers was compared with food availability (Fig. 2b), several trends were evident. Orthopterans were fed in about the same proportion as their availability except in July when they were fed in greater amounts ($\chi^2 = 11.7$, df = 1, $P < 0.01$) than expected. Gastropods, although second only to orthopterans in total availability, were avoided and their contribution to diet was minimal. Lepidopterans and arachnids apparently were taken in about the same quantities as their respective availabilities each month.

CONCLUSIONS

The growth and developmental characteristics of each mimid examined in this and other studies were similar, although there was a trend for the smaller species to develop more rapidly. Mimids as a group, and especially thrashers of the genus *Toxostoma,* appear to fledge at lower young/adult weights than most other passerines studied so far (Ricklefs 1968). Of the 56 passerine species examined by Ricklefs, only the Horned Lark (*Eremophila alpestris*) fledged at a lower R value than the Curve-billed Thrasher. Predation pressures were great during both years of this study (Fischer 1980), perhaps favoring a short nestling period with much additional growth delayed until after fledging.

SUMMARY

The growth, development, and food habits of nestling Curve-billed Thrashers (*Toxostoma curvirostre*), Long-billed Thrashers (*T. longirostre*), and Northern Mockingbirds (*Mimus polyglottos*) were studied during the summers of 1977 and 1978 in south Texas. The young of each species were typically altricial. The overall growth rates of Curve-billed and Long-billed thrashers were similar (K = 0.444 and 0.443, respectively) and somewhat slower than the smaller mockingbird (K = 0.452) or Sage Thrasher (K = 0.543, using Killpack's 1970 data). Nestling mimids fledged at weights lower than those of adults. At fledging, none of the young mimids could fly and the wing chords were much shorter than those of the adults. Bill lengths of each species were also less than adult measurements. The tarsometatarsus of each mimid species grew rapidly and by day 8, it had attained at least 80% of the adult length.

The nestling diets of each species overlapped broadly and were dominated numerically and volumetrically by orthopterans. Other major prey were coleopterans, lepidopterans, and arachnids. The diet of nestling Curve-billed Thrashers changed relatively little between May and July.

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